Team Seldon

Simulation of Extreme Transitions in Social Dynamic

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Who is Seldon?

- Hari Seldon
  - Character in Foundation Trilogy (Isaac Asimov)
  - Psychohistory: mathematics of social change; reactions of very large human populations to social and economic stimuli
- Two axioms:
  - Large numbers of people
  - Results cannot be disclosed

Seldon Objective and Approach

- Purpose: to better understand the factors and processes that lead to the emergence and persistence of extra-legal violent groups
  - Question: how can we intervene in the recruitment pipeline so these groups do not achieve the size and structure necessary to support violent behavior?

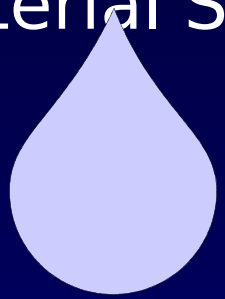
- Approach: use American urban street gangs as subject matter for basic architecture

System vs Complexity Theory

- Aggregate as organism

Examples:

- Macroeconomics
- Aerodynamics
- Material Science

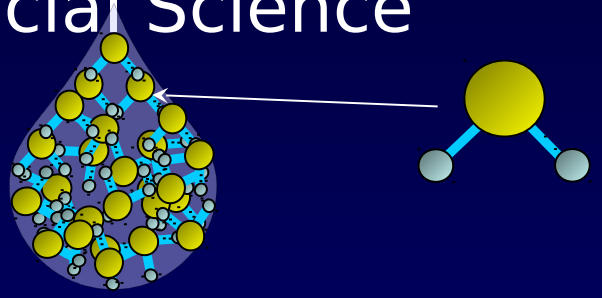


water

- Sub-unit as organism

Examples:

- Nanotechnology
- Computational Social Science



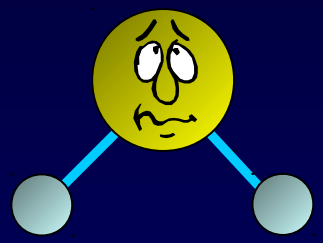
H_2O

Social Dynamics Simulated through Agent-Based Modeling

- Benefits of ABM
  - Represents behavior at agent level, not as aggregate
  - Represents agents and their actions as distributions
  - Incorporates non-linearity intrinsically
  - Explores processes, rather than just states
- Challenges of ABM
  - Requires understanding of behaviors at high fidelity
  - Requires codification of previously qualitative social theories
  - Presents challenging validation

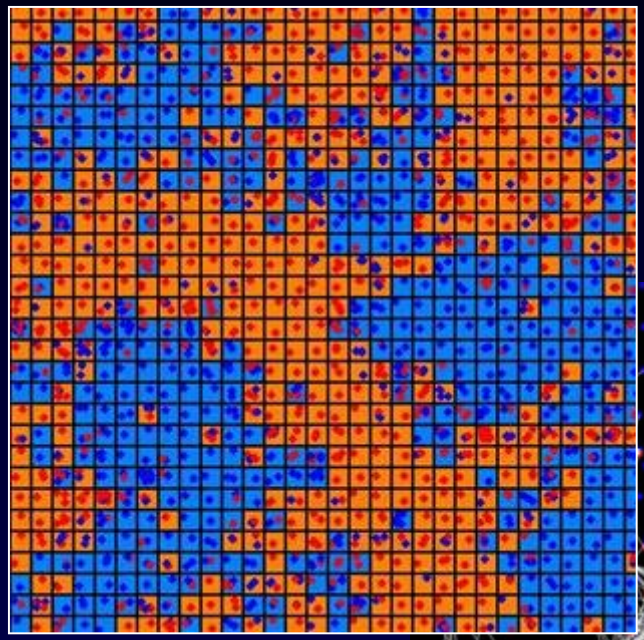
Interest in Waves, not Ripples

What about individual H_2O?



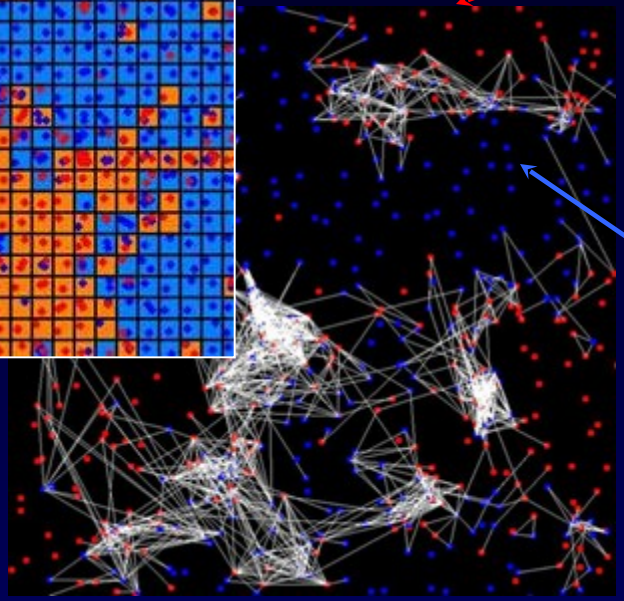
Forget about it…

Integration of Computational Tools



Agent Based Model

Explore group behavior such as recruitment and violence



Social Network Analysis

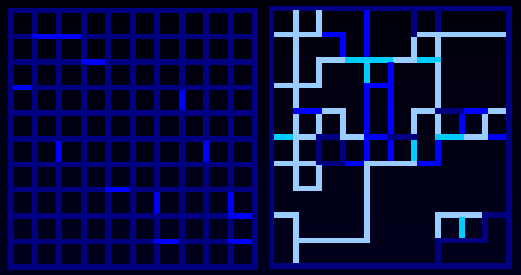
Emergent group structures

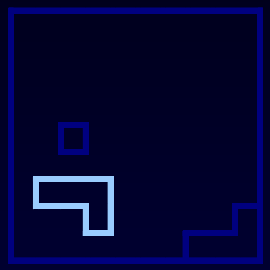
Behavioral and Cognitive Models

Social Simulation Today

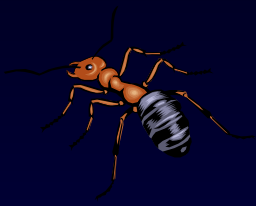
- Simple benevolent behavior
- Focus on emergent group behaviors
- Limited communication
- No societal representation
- No history

Cultures

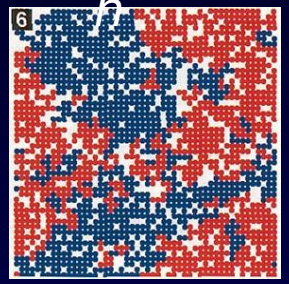




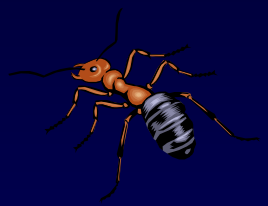
(Axelrod, 1997)



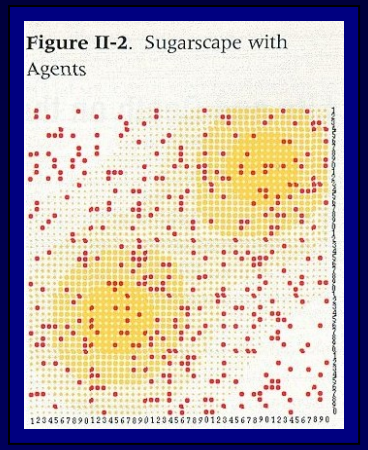
Desegregation



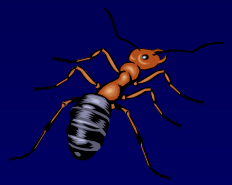
(Epstein and Axtell, 1996)



Sugarscape



(Epstein and Axtell, 1996)



FY03 Plans

- Design and Develop initial terrorist model
  - Analogy between terrorist and gang organization
- Design and Develop agent-based social simulation toolkit
  - Preliminary recruitment model
  - Extensible model and simulation environment
  - Social network(s) representation
  - Interactive GUI
  - Preliminary visualization tools for analysis

Recruitment Model

- Competing Agents: Gang vs School*
- Characteristic time is months
- Teen Agents
  - Hi or Lo Attendees (frequency of school attendance)
  - Gang or Non-gang (tags)
  - 3 potential social networks (conduits)
    - Potential network is recognized system of social relationships (friendship, schoolmate, gang…)
  - No agent goals. Must contact other agents daily.

**F.H.G. Gilyard, "The Competition between Gangs and Schools, PhD Thesis, 1999.*

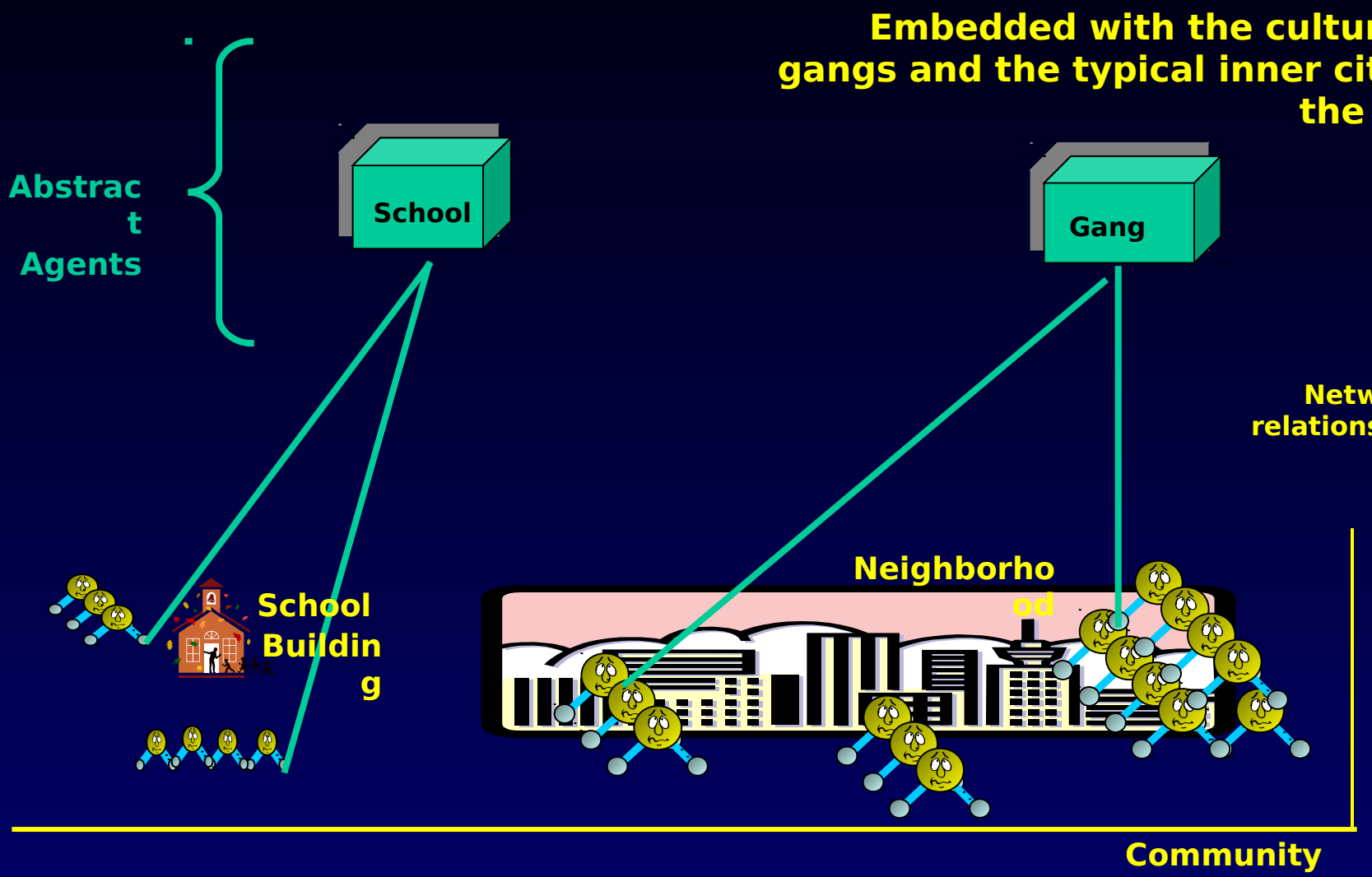
Questions We Can Ask

- How does frequency of school attendance affect gang affiliation?
- How will interaction with non-gang members affect gang affiliation over time?
- How strong does a preference for interaction with friends/schoolmates have to be to overcome a preference for interaction with gang members?

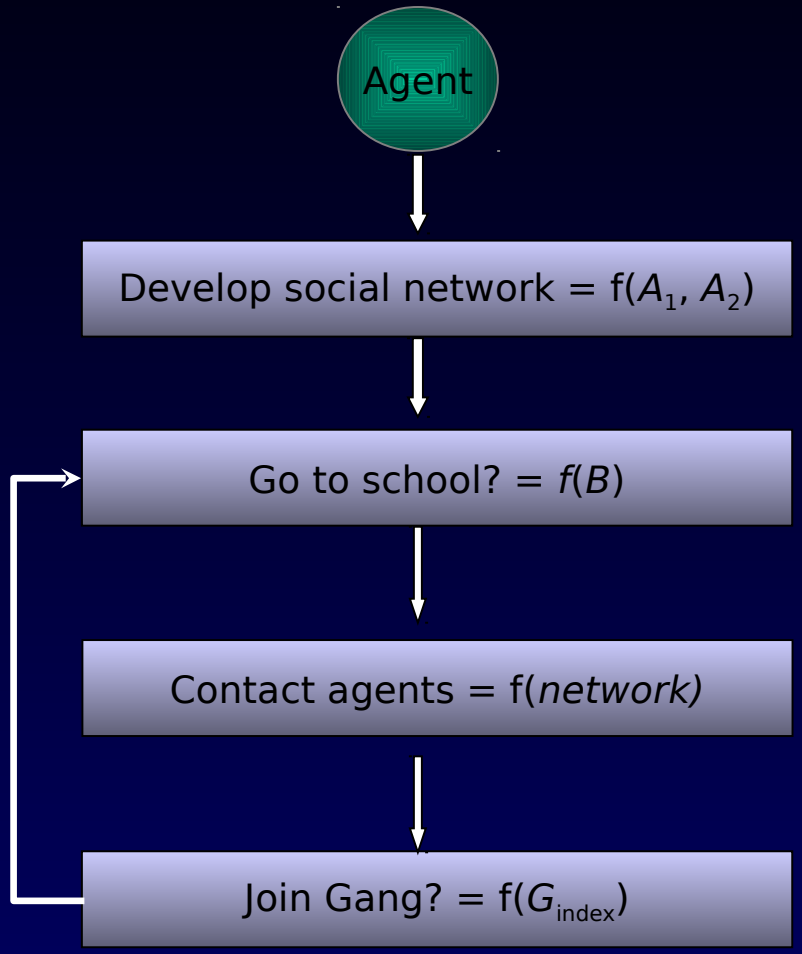
Questions translated to terrorists

- How does frequency of attendance [at some socially positive institution] affect terrorist group affiliation?
- How will interaction with non-terrorist members affect gang affiliation over time?
- How strong does a preference for interaction with friends/family(?) have to be to overcome a preference for interaction with terrorist group members?

Framework for Socialized Agents



A Day in the "Life" of an Agent



Parameter List

N_A = # agents (200)

B = Hi-Attendee, or Lo-Attend

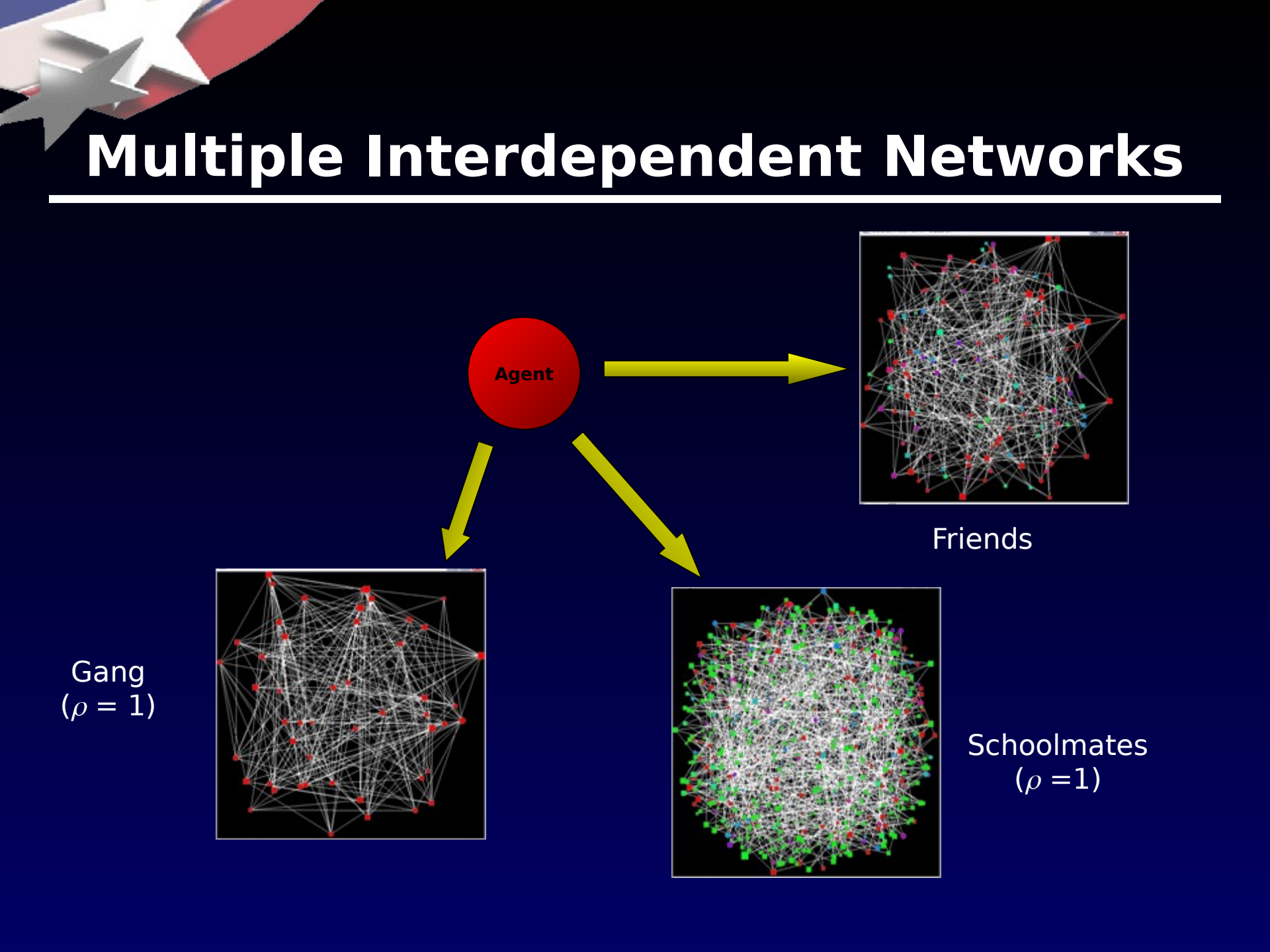
P = Probability of going to school: f(B)

G_{index} = Gang Index f(School Attendance – Gang Contacts)

A_1 = Attribute 1 (binary - blue eyes)

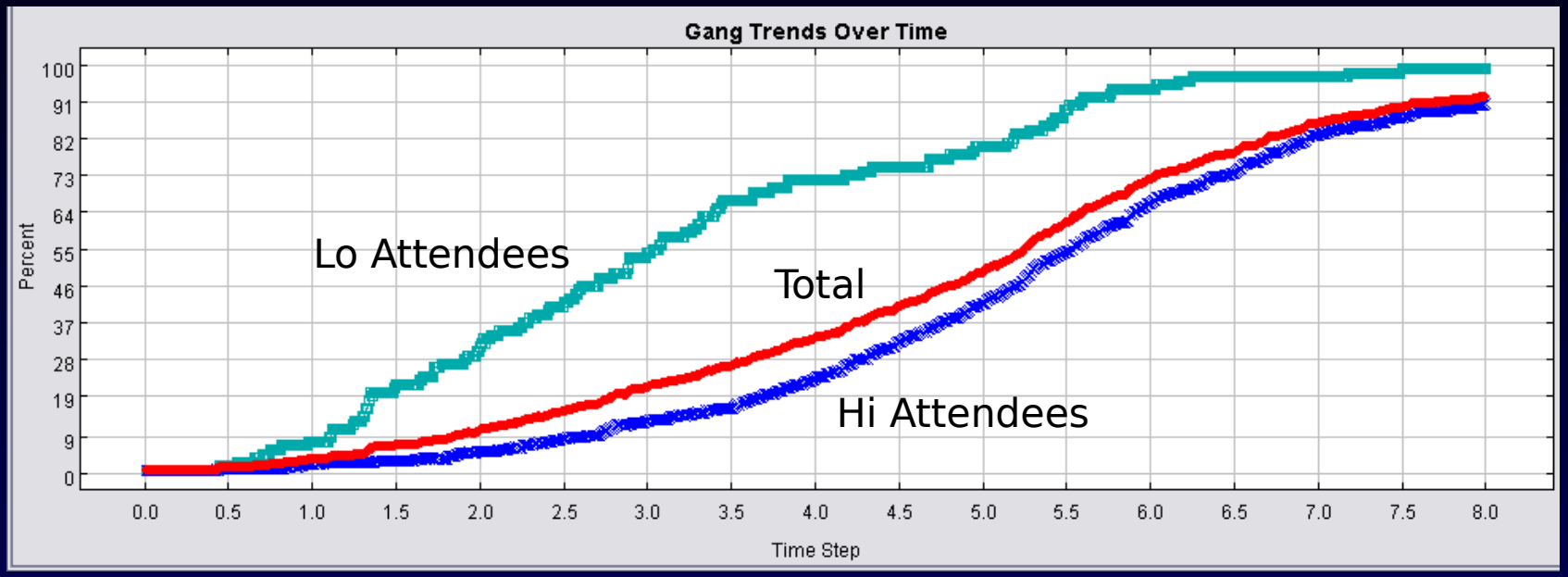
A_2 = Attribute 2 (binary - blue hair)

Multiple Interdependent Networks



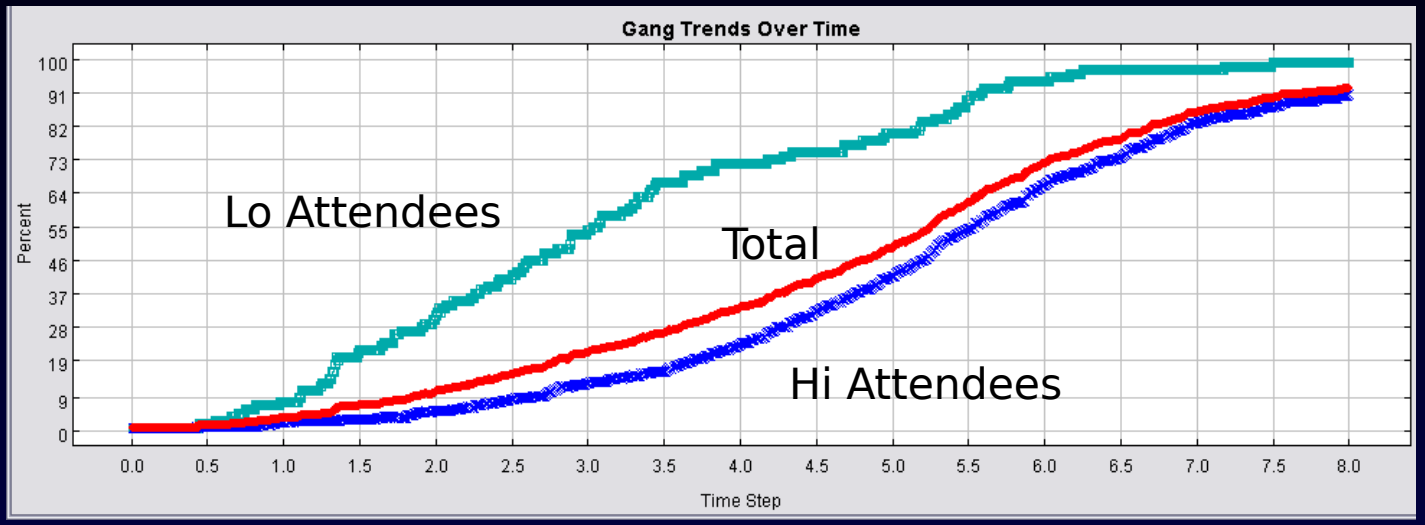
Demonstration

Aggregate Data on Gang Population

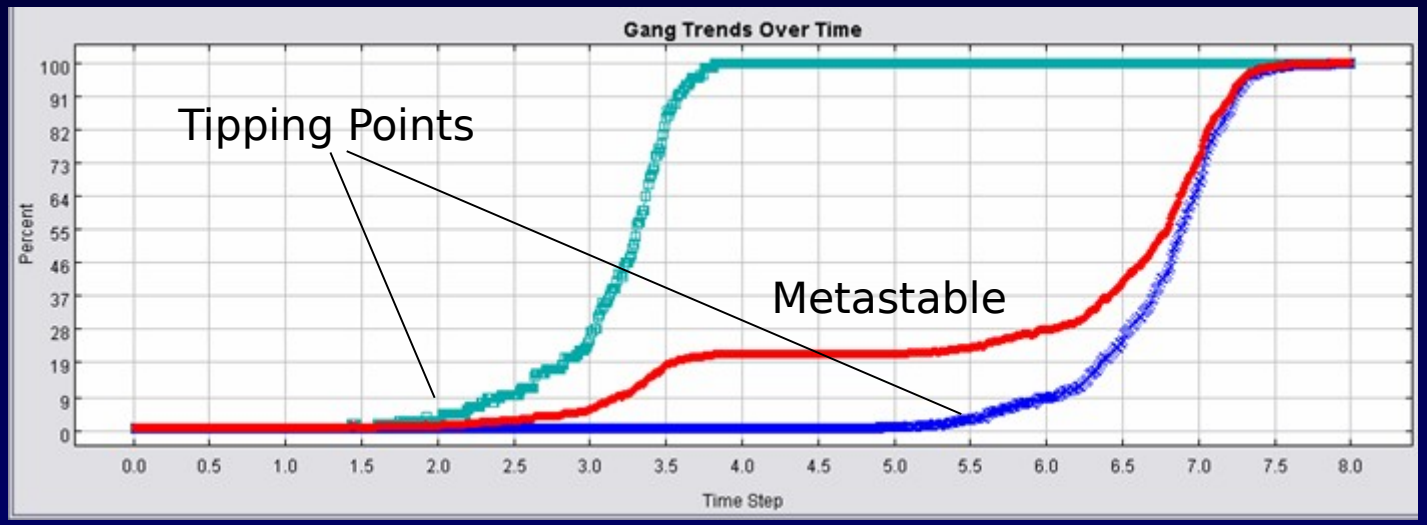


- 500 Total Agents
- 5 Initial Gang Agents (“Hard Core”)
- Hi/Lo attendees = 80/20
- Network Density ρ =1%

Effect of Network Density on Recruitment

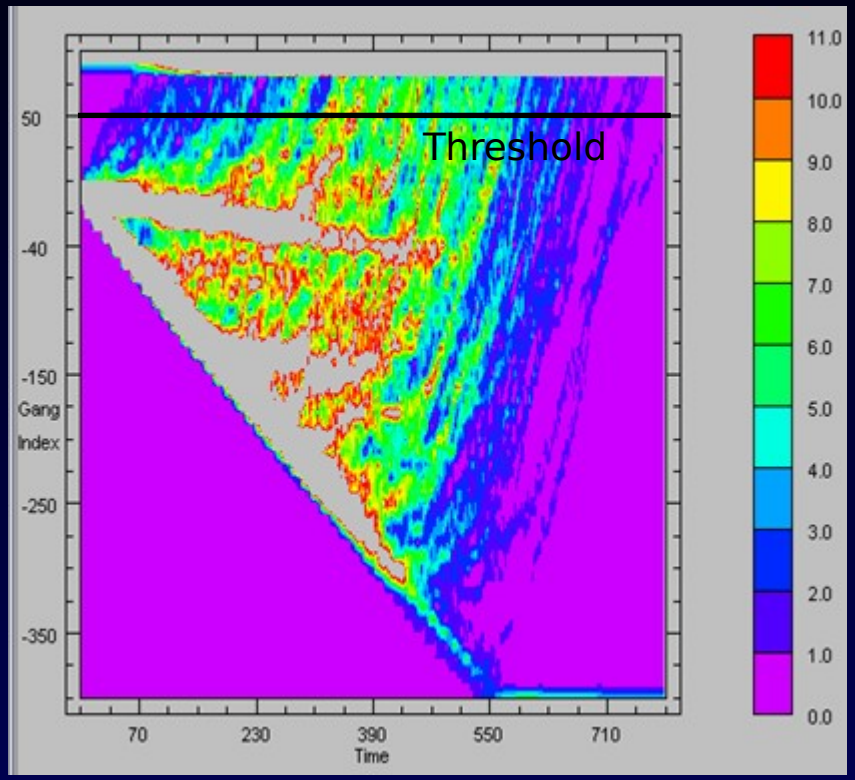


ρ =1%

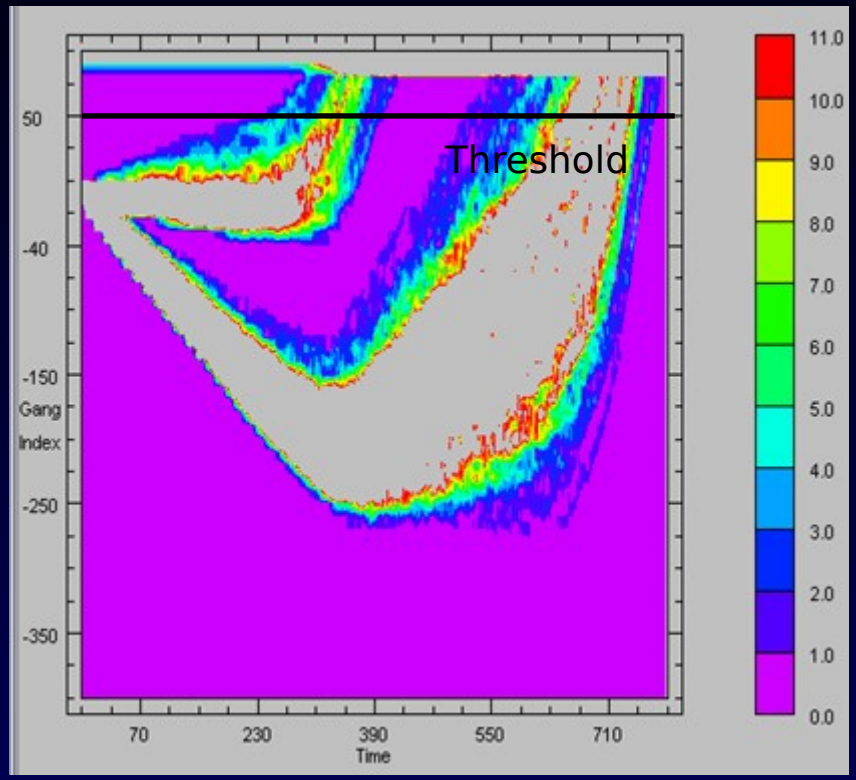


ρ =16%

Effect of Network Density on Recruitment



Network Density = 1%
(Final Gang Population = 97%)

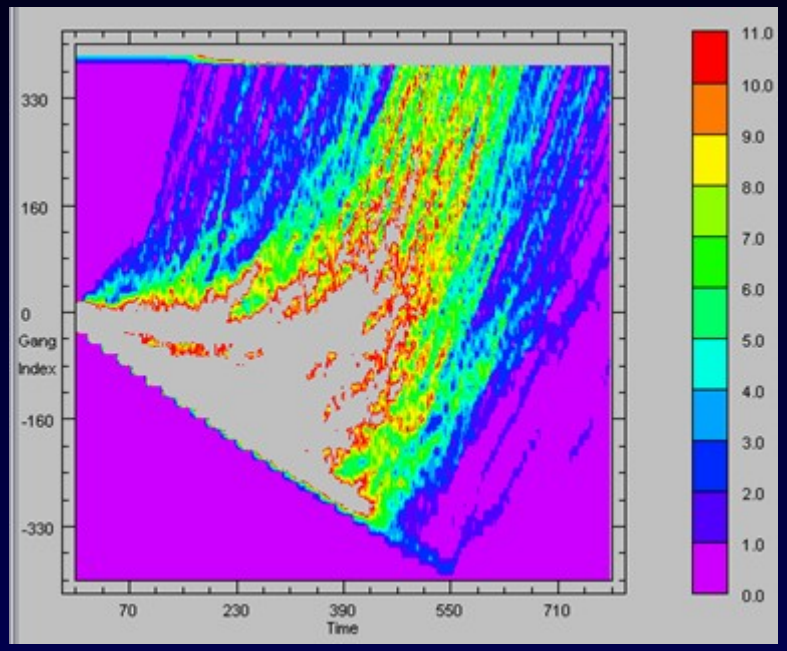


Network Density = 16%
(Final Gang Population = 100%)

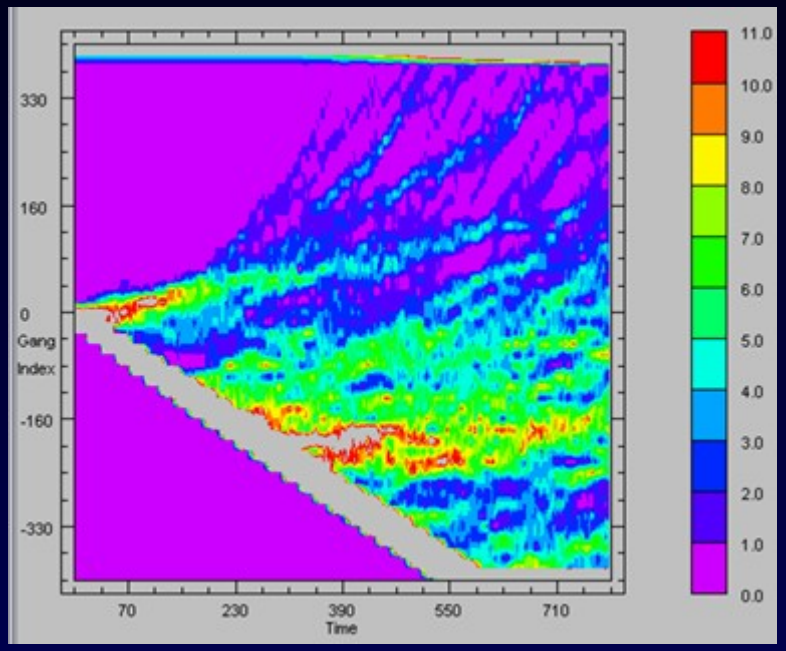
Potential Intervention Testing

- Improve school attendance in Lo Attendees
- Non-gang members influencing gangs
- Non-gang members keeping other non-gang out of gangs
- Improve “School Effectiveness” – increase school weight
- Educate non-gangs to resist gangs – increase gang threshold

Effect of School Attendance on Recruitment

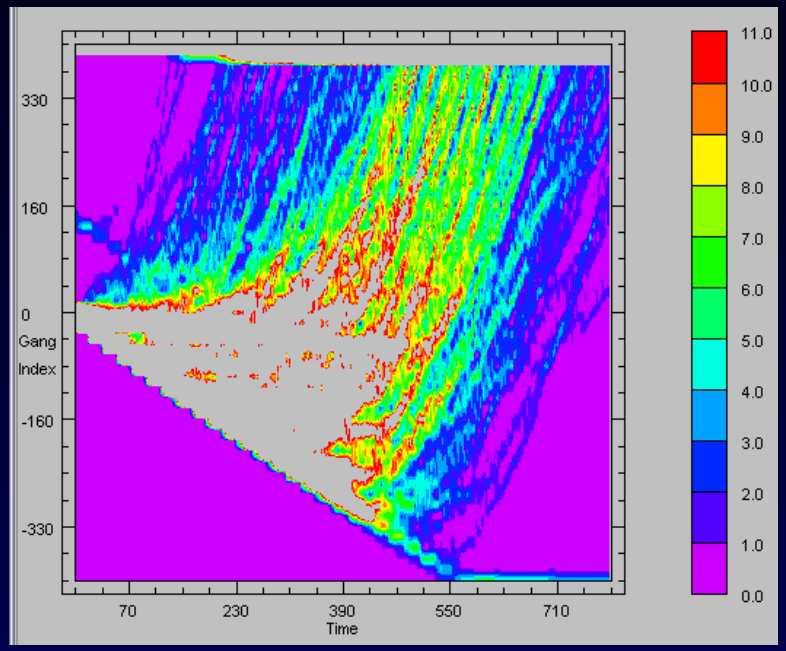


Ave Attendance (Lo Attend) = 10%
(Final Gang Population = 99%)

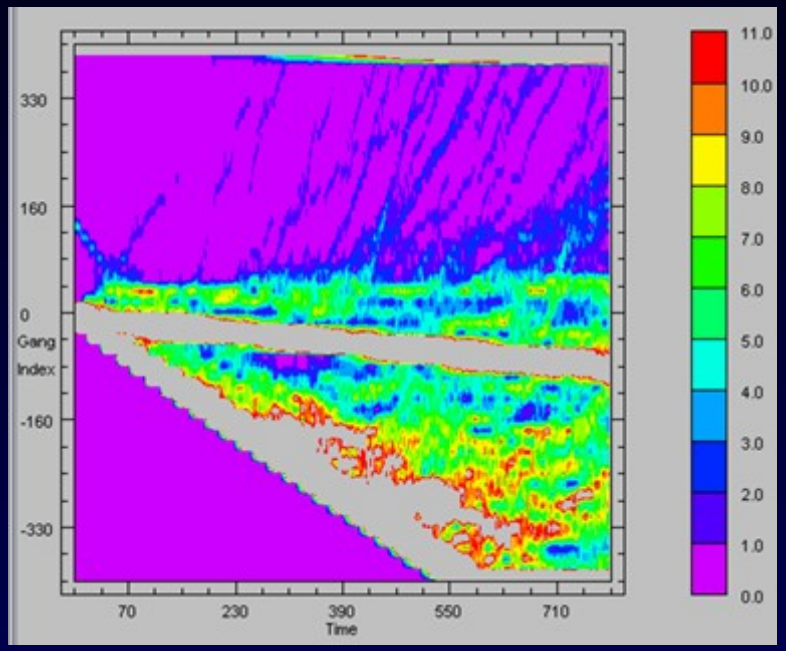


Ave Attendance (Lo Attend) = 70%
(Final Gang Population = 13%)

Non-gang influencing Gang

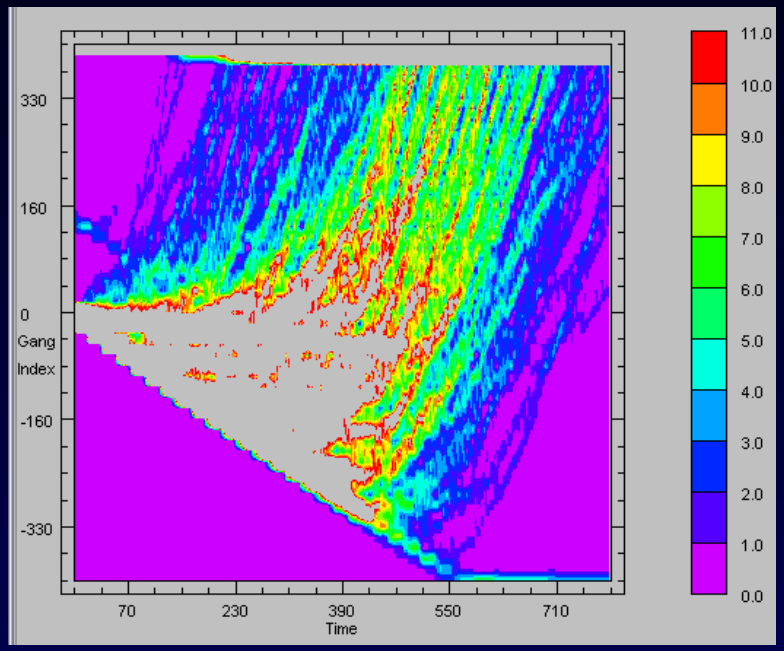


NG-to-G/G-to-NG = 0
(Final Gang Population = 99%)

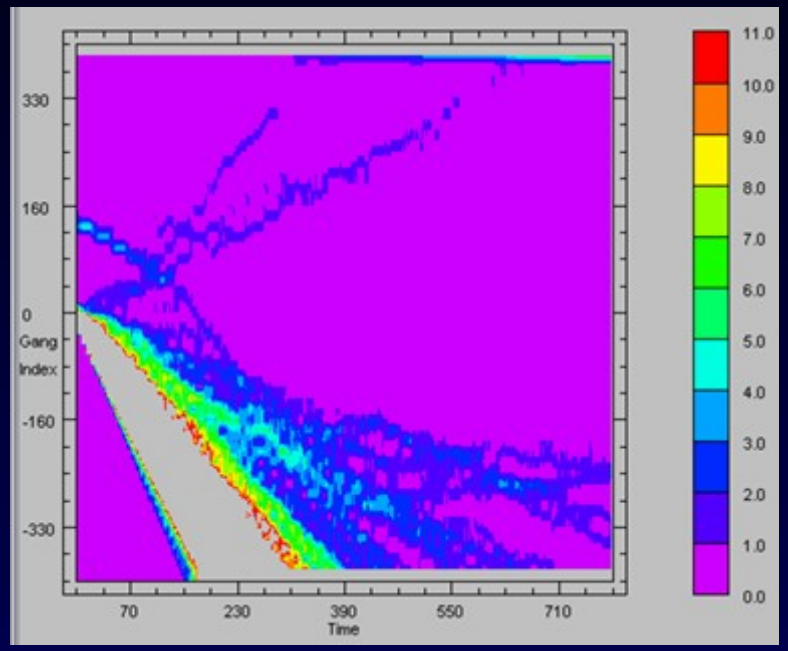


NG-to-G/G-to-NG = 0.2
(Final Gang Population = 14%)

Non-gang influencing Non-gang

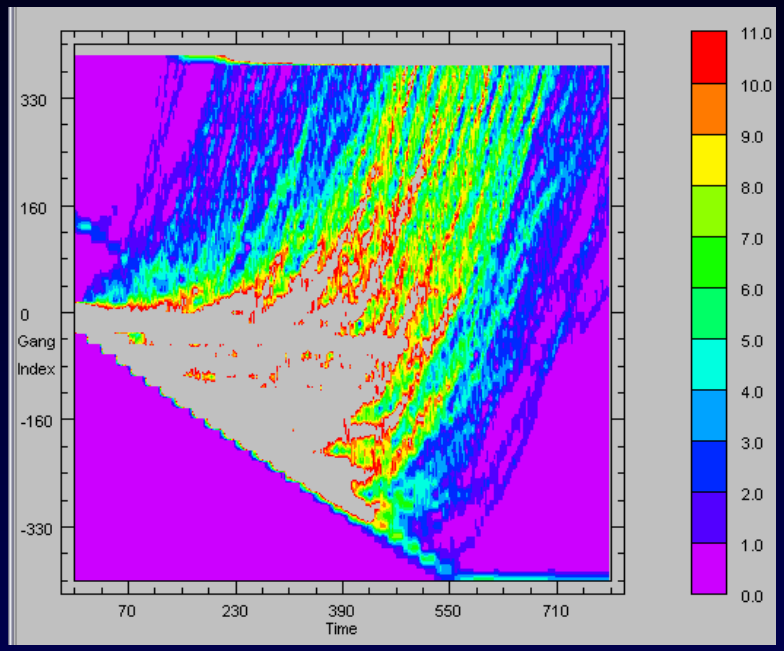


NG-to-NG/G-to-NG = 0
(Final Gang Population = 99%)

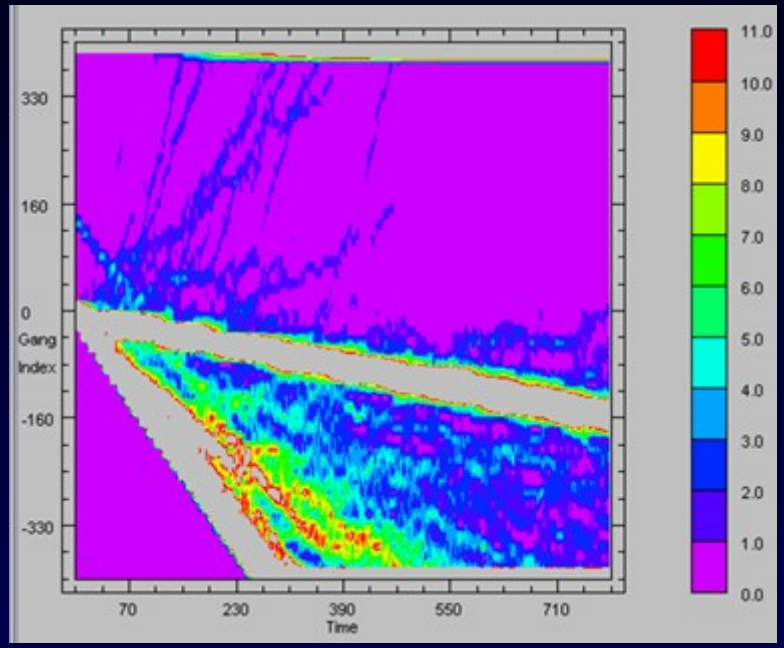


NG-to-NG/G-to-NG = 0.2
(Final Gang Population = 1%)

Improve “School Effectiveness”

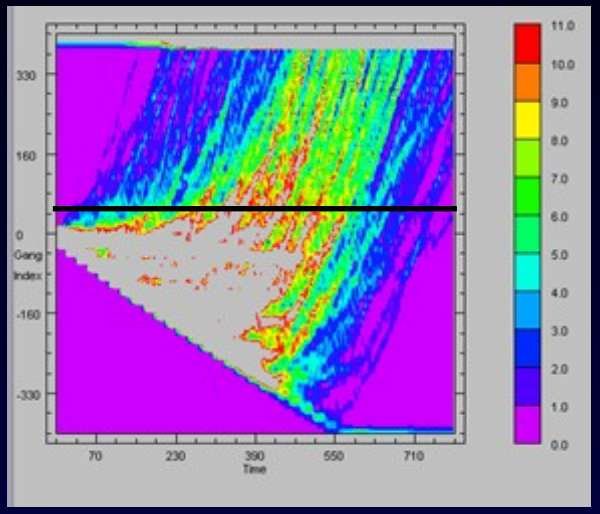


School Wt/Gang Wt = 1
(Final Gang Population = 99%)

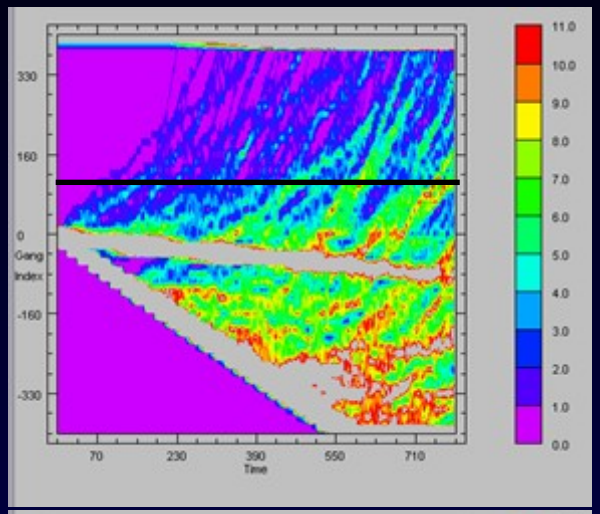


School Wt/Gang Wt = 2
(Final Gang Population = 5%)

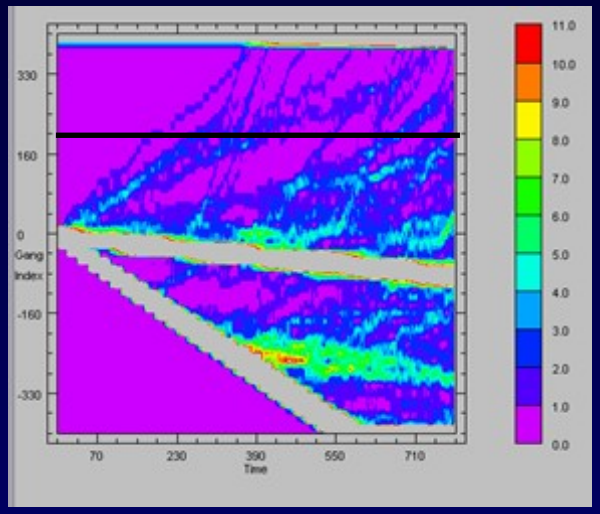
Educate Non-gangs to Resist Gangs



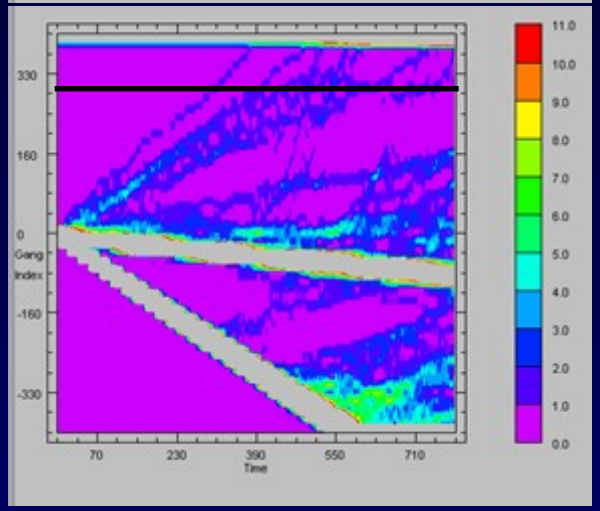
G_T = 50
Final Gang
= 97%



G_T = 100
Final Gang
= 38%



G_T = 200
Final Gang
= 8%

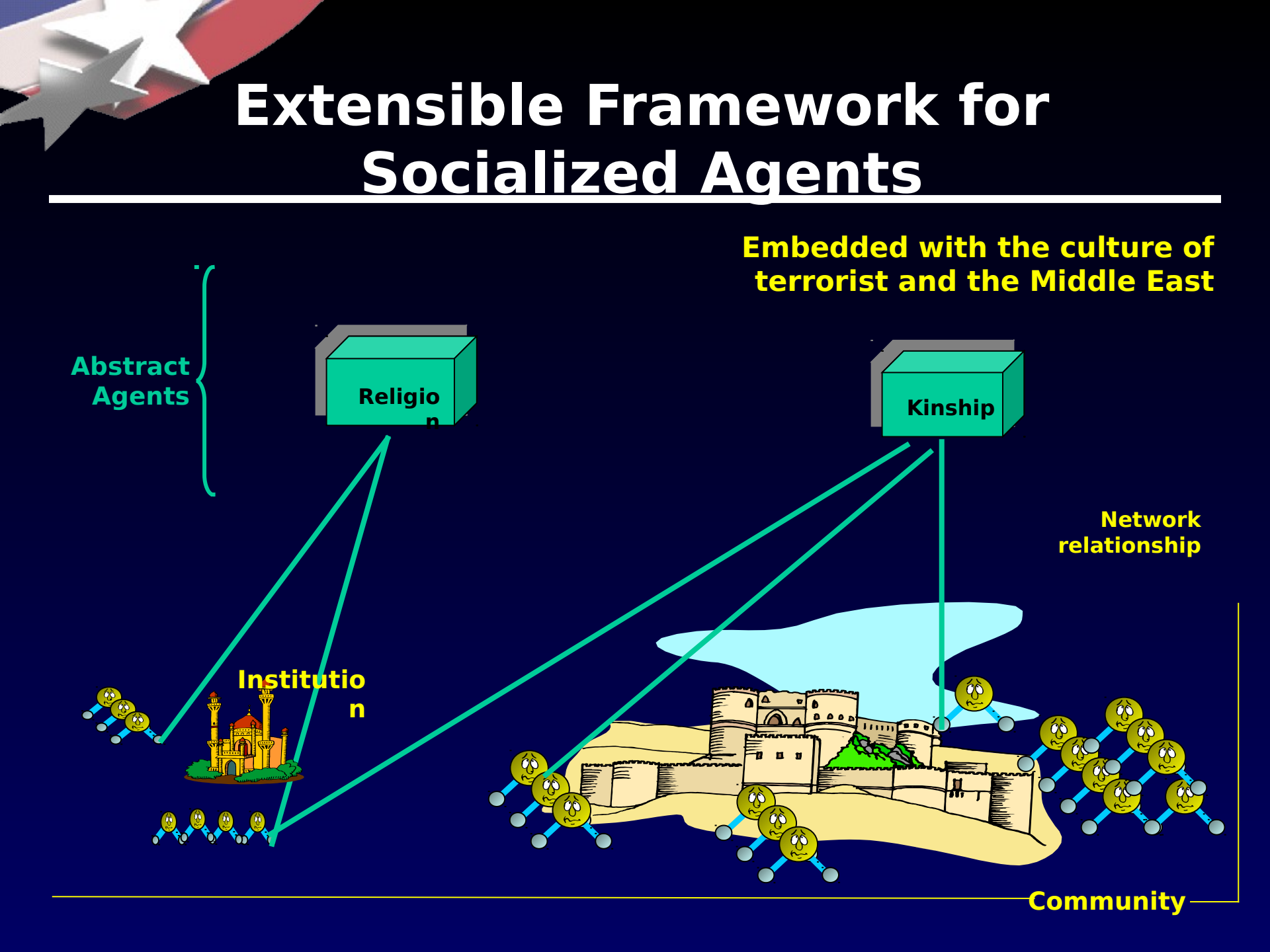


G_T = 300
Final Gang
= 3%

FY03 Progress to date

- Completed software prototype supporting a terrorist recruitment model
  - ✓ Developed extensible agent-based framework
    - Abstract agents
    - Multiple social networks
  - ✓ Developed runtime environment
    - Run options GUI and command-line
    - Fundamental visualization tools
  - (✓) Tested within a gang environment
- Terrorist structure development (in progress)

Extensible Framework for Socialized Agents



Limitations

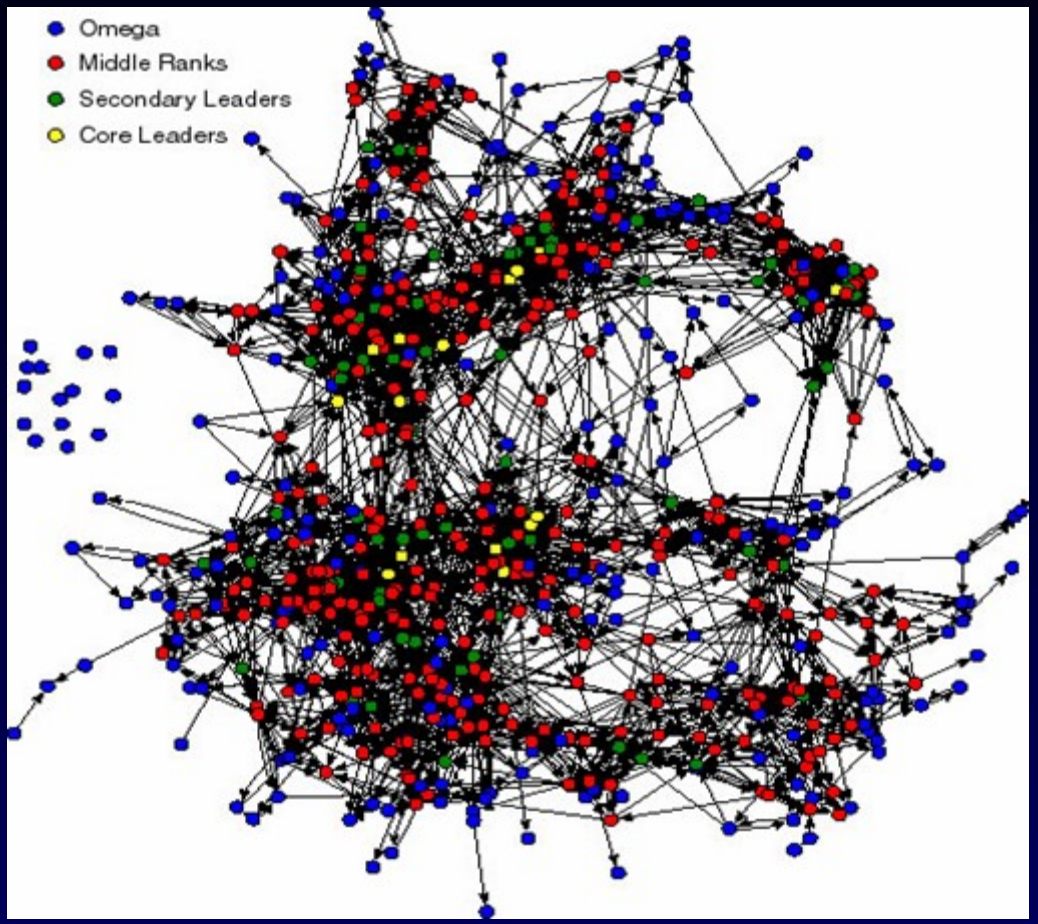
- Current model consists of:
  - Static agents and social networks
  - Linear system with no dynamic feedback
  - Limited heterogeneous development
  - Multiple social networks that do not interact
  - Model output is not matrix based
  - Visualization is inadequate
    - Only runs in real-time
    - Initial set of packages integrated
  - No statistical analysis exist
  - No structured communication/interaction model

FY04 Challenges

Middle eastern terrorists recruitment model development

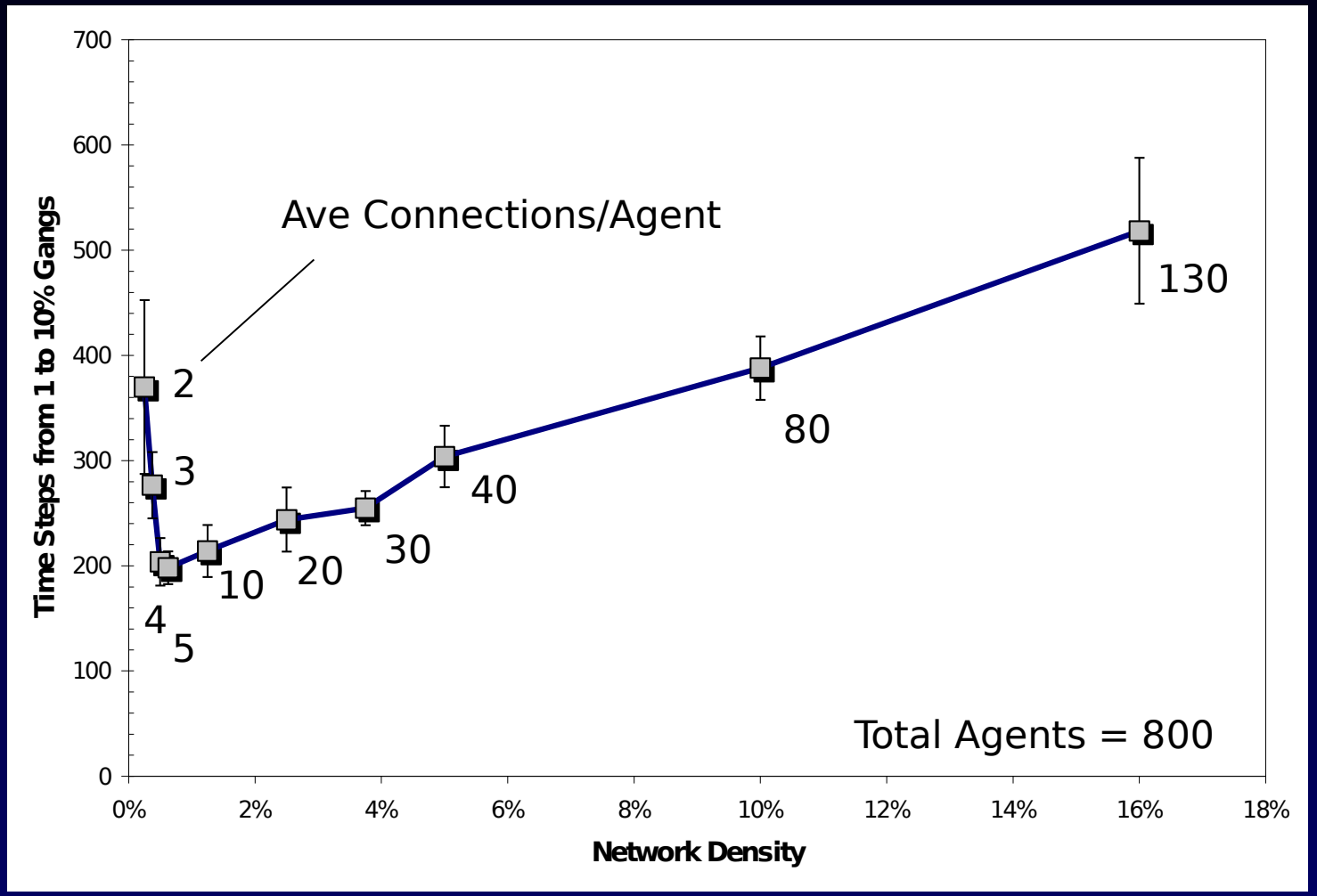
- Augment current model to integrate new knowledge of terrorist organizations
  - Conceptual agents
    - (i.e., Kinship, Religion, Mosques, Neighborhood, Brotherhood)
- Integrate new components/sub-models
  - Extensions to behavior model for terrorist
    - Increased heterogeneous behavior
  - Communication/interaction model
    - Charismatic leader
  - Physical world model
- Cognitive model layer

U.S. Teen Social Network



James Moody, PhD Thesis, 1999, page 123.

Effect of Network Density



Increase Anti-gang Sentiment